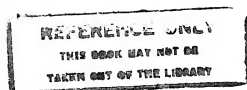

The control of legionellosis including legionnaires' disease

Health and Safety Series booklet HS(G)70



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HS(G) series

The purpose of this series is to provide guidance for those who have duties under the Health and Safety at Work etc Act 1974 and other relevant legislation. It gives guidance on the practical application of legislation, but it should not be regarded as an authoritative interpretation of the law.

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INTRODUCTION

1 This booklet replaces Guidance Note EH 48 *Legionnaires' disease* published in January 1987. It was recognised in EH 48 that revision would be necessary as research into the disease and its causes progressed. This publication, HS(G)70, therefore reflects this progress and takes account of the circumstances concerning the outbreaks and cases of legionnaires' disease that have occurred since 1987. Knowledge of this disease and its causes is still advancing so that further revision may be necessary.

2 The first identified outbreak of legionnaires' disease occurred among people who had attended a Pennsylvania State Convention of the American Legion in 1976. An apparently new bacterium was isolated from lung specimens. Retrospective examination of stored specimens from previously unsolved outbreaks of respiratory illness revealed that some of these cases were also caused by the bacterium now known as *Legionella pneumophila*. In 1976 the disease was therefore not new but newly recognised.

3 *L. pneumophila* can also cause a short febrile (feverish) illness without pneumonia known as Pontiac fever. Since *L. pneumophila* was originally isolated several other species of legionella capable of causing pneumonia have been described in the UK and elsewhere. The 1988 outbreak of non-pneumonic legionellosis at Lochgillhead in Scotland, now referred to as Lochgillhead fever, was attributed to the species *L. micdadei*. Legionellosis is the generic term used to cover legionnaires' disease, Pontiac fever and Lochgillhead fever.

MICROBIOLOGY

4 Legionella is the name given to a genus of bacteria of which *L. pneumophila* is one species. Under the microscope legionella appear rod-shaped. Legionella organisms are widespread in natural water sources and have been found in rivers, lakes, streams, mud and soil as well as man-made water systems. To date, at least 34 different species of legionella are recognised. The species most commonly associated with disease outbreaks is *L. pneumophila*, which is apparently the most pathogenic of the genus. Fourteen different serogroups of *L. pneumophila* have been described. *L. pneumophila* serogroup 1 is the most commonly associated with cases of legionnaires' disease in the UK although other serogroups have been associated with outbreaks worldwide. Several other species of legionella have been found to cause a pneumonia type illness, including *L. feelei* and, as previously mentioned, *L. micdadei*.

5 The ecology of legionella in water systems is not fully understood. However, the following conditions have been found to affect its rate of growth:

- (a) water temperatures in the range of 20 to 45°C favour growth. It is uncommon to find proliferation below 20°C, and it does not survive above 60°C. The optimum laboratory temperature for the growth of the bacterium is 37°C. Organisms may, however, remain dormant in cool water, multiplying only when the temperature reaches a suitable level;
- (b) the presence of sediment, sludge, scale and organic material can act as a source of nutrients for legionella;
- (c) legionella have been shown to colonise certain types of water fittings, pipework and materials used in the construction of water systems. The presence of such materials may provide nutrients for legionella and can make eradication difficult;
- (d) commonly encountered organisms in water systems such as algae, amoebae and other bacteria may serve as an additional nutrient source for legionella. Algal slime may provide a stable habitat for multiplication and survival. Legionella can grow in protozoa and it has been shown to proliferate rapidly in waterborne amoebae;
- (e) the formation of a biofilm within a water system is thought to play an important role in harbouring and providing favourable conditions in which legionella can grow. A biofilm is a layer of micro-organisms contained in a matrix which may form a slime on surfaces in contact with water. Incorporation of legionella in biofilms and enclosure within protozoa can protect the organisms from concentrations of biocides that would otherwise kill or inhibit those organisms freely suspended in water.

6 In the laboratory *L. pneumophila* is recovered from concentrated water samples by propagation of the organism on a specially supplemented nutrient growth medium. Such samples are normally then incubated at around 37°C; it may take up to seven days for colonies of legionella to initially appear. Legionella can be recognised by visual examination of the colonies followed by a number of laboratory techniques to identify species and serogroup.

MEDICAL ASPECTS

7 Legionnaires' disease is a type of pneumonia. Besides affecting the lungs it may also have serious effects on other organs of the body. Infection is caused

by inhaling airborne droplets or particles containing viable legionella which are small enough to pass deep into the lungs and be deposited in the alveoli. There is no evidence that the disease is transmitted by ingestion or from person to person. The dose of legionella required to infect man is not known and there is reported to be a 1% attack rate, so that for every 100 persons exposed generally only one will develop symptoms of disease. Legionnaires' disease can have an incubation period of two to ten days but is more usually three to six days. Males are more likely to be affected than females by a ratio of about 3:1. Most reported cases have occurred in the 40 to 70 year age group. Although healthy individuals may develop legionnaires' disease, people thought to be at an enhanced risk of infection include smokers, alcoholics and patients with cancer, chronic respiratory or kidney disease. The case fatality rate is approximately 12% but in immunosuppressed patients or those with other underlying disease this figure may be higher. Legionnaires' disease may be treated effectively with several antibiotics including erythromycin and rifampicin. Recent experiments have shown the effectiveness of azithromycin.

8 Initial symptoms of legionnaires' disease include high fever, chills, headache and muscle pain. A dry cough soon develops, and most patients suffer difficulty with breathing. About a third of patients also develop diarrhoea or vomiting and about half become confused or delirious. Legionnaires' disease may not always be severe and in community outbreaks mild cases may be recognised which would probably have escaped detection except for the increased awareness of the disease in such a situation.

9 Exposure to legionella can lead to Pontiac fever which is a milder condition of acute onset with an incubation period of between five hours and three days. The illness usually lasts between two and three days. However, in an outbreak in Lochgoilhead in Scotland in 1988 (referred to as Lochgoilhead fever) the incubation period was longer and in some cases up to nine days. Symptoms also lasted longer in some cases (up to 14 days) and in some patients the symptoms recurred. The symptoms of Pontiac fever are similar to those of moderate to severe influenza: headache, tiredness, fever, arthralgia and myalgia and, in a small proportion of cases, nausea, vomiting and coughing. No deaths have been reported. A high percentage of those exposed to risk develop Pontiac fever, which, as previously described, is not the case with legionnaires' disease.

10 It is important to keep the incidence of the disease in perspective. In recent years up to 300 cases of legionnaires' disease are reported each year in England and Wales whereas there are 180 000 estimated cases of pneumonia from all causes. Many cases of legionnaires' disease are in patients who have recently travelled abroad. Infections which originate in this

country are often sporadic cases for which no source of infection is traced. However clusters of cases have occurred, for example, outbreaks associated with hotels, factories, hospitals and other establishments such as those associated with recent outbreaks in London.

SAMPLING FOR LEGIONELLA

11 As legionella are common in natural water sources, random sampling of water systems and services for the bacterium will often yield positive results. Even where sampling results are negative there is no guarantee that it is not present elsewhere in the system. The dose of legionella required to infect man, the variation in response of exposed individuals and the variation in pathogenicity of different strains are not fully understood. It is therefore difficult to determine risk solely on the basis of water sampling results. For these reasons, random water sampling for legionella is not advocated.

12 Sampling for legionella is separate and different from sampling to assess water quality (paragraph 118 refers). Water sampling for legionella may sometimes be required to monitor the efficacy of precautionary measures such as a water treatment regime or to trace the source of an infection. It should be carried out to a suitable protocol by people who are competent and experienced in sampling for legionella and interpreting results. It is especially important that any decision to sample should not divert resources from precautionary measures, and negative results should not lead to complacency or a relaxation of standards.

13 Cooling towers and associated water systems should be subject to routine monitoring of water quality as part of the water treatment programme designed to control scaling, corrosion and fouling. This is considered in more detail in paragraphs 116 to 123.

LEGISLATION

14 The Control of Substances Hazardous to Health Regulations 1988 (COSHH) relate to the risks from hazardous micro-organisms, including legionella and chemicals such as biocides and chlorine. Under these Regulations risk assessments and the adoption of appropriate precautions are required to be made.

15 The Approved Code of Practice *The prevention or control of legionellosis (including legionnaires' disease)* sets out further statutory requirements for dealing with this risk. It applies whenever water is stored and used in a way which may create a reasonably foreseeable risk of legionellosis and in particular to the following plant and systems whenever the Health and Safety at Work etc Act 1974 applies:

- (a) water systems incorporating a cooling tower;

- (b) water systems incorporating an evaporative condenser;
- (c) hot water services, except where the volume of hot water in the system does not exceed 300 litres;
- (d) hot and cold water services irrespective of size in premises where occupants are particularly susceptible, such as health care premises;
- (e) humidifiers and air washers which create a spray of water droplets and in which the water temperature is likely to exceed 20°C;
- (f) spa baths and pools in which warm water is deliberately agitated and recirculated.

16 While this is not an exclusive list it identifies those systems most likely to cause infection. Other plant and systems containing water which is likely to exceed 20°C and which can release a spray or aerosol (a cloud of water droplets and/or particles) during operation or when being maintained may also present a risk.

17 The Approved Code of Practice (ACOP) places responsibility on employers and others to:

- (a) identify and assess sources of risk;
- (b) prepare a scheme for preventing or controlling the risk;
- (c) implement and manage precautions;
- (d) keep records of the precautions implemented.

18 The ACOP also sets out the responsibilities of manufacturers, importers, suppliers and installers of products and services. It is enforced by Health and Safety Executive inspectors in factories, hospitals, laboratories, education establishments, docks and construction sites. In shops, offices, warehouses, hotels and catering establishments it is enforced by local authorities who also have responsibilities for public health. Recent outbreaks of legionnaires' disease in the UK have demonstrated the implications for public health.

19 Duties under the ACOP are qualified by the condition that they must be 'reasonably practicable'. This means that both the degree of risk and the cost and difficulty of applying control measures should be accounted for in determining what measures should be taken.

IDENTIFICATION AND ASSESSMENT OF RISK

20 Systems susceptible to colonisation by legionella and which incorporate a potential means for creating and disseminating water droplets should be identified and the

risk they present should be assessed. Risk should be assessed not just for the routine operation or use of the system but also in relation to breakdown, abnormal operation, commissioning or unusual circumstances.

21 The assessment should take account of:

- (a) the potential for droplet formation;
- (b) water temperature;
- (c) the likely risk to those who will inhale water droplets;
- (d) means of preventing or controlling the risk.

22 Droplets may be created in various ways such as by spraying, bubbling and impact with hard surfaces. Large drops may be reduced to respirable size by further impact or evaporation, and these smaller particles may persist for long periods or be carried on air currents.

23 In assessing risk and drawing up precautions particular attention should be paid to circumstances where:

- (a) the population contains a high proportion of susceptible people as, for example, in many hospitals and nursing homes; or
- (b) the number of people at potential risk is high as, for example, in densely populated areas.

24 The list in paragraph 15 of this booklet may be assumed, in normal circumstances, to include all currently known sources where the risk is sufficient to warrant the measures required in the Approved Code of Practice. This does not mean that the list includes all possible sources, or that cases of legionnaires' disease will be avoided by applying precautions solely to the systems and plant listed. Whenever a risk is identified all reasonably practicable precautions should be applied. However, experience to date indicates that the risk from plant and systems, other than those in paragraph 15, will normally be very small.

DRAWING UP AND APPLYING PRECAUTIONS

25 Once the risk has been identified and assessed, a scheme should be prepared for preventing or controlling it. The primary objectives should be to avoid conditions which permit legionella to proliferate and to avoid creating a spray or aerosol. Where this is impractical, the risk may be controlled by minimising the release of droplets and by preventing water conditions which permit legionella to proliferate. Legionella may be present in very low concentrations in many water systems but by careful control it will be prevented from multiplying.

26 The application of precautions to specific systems is discussed in later paragraphs. In general, proliferation may be avoided by:

- (a) avoiding water temperatures between 20°C and 45°C. Water temperature is a particularly important factor in the control of risk;
- (b) avoiding water stagnation. Stagnation may encourage the growth of biofilm (slimes that form on surfaces in contact with water) which can harbour legionella and provide local conditions that encourage its growth. If water is allowed to stand for long periods in a warm building or in hot weather its temperature is more likely to rise above 20°C;
- (c) avoiding the use of materials in the system that can harbour or provide nutrient for bacteria and other organisms;
- (d) keeping the system clean so as to avoid the build up of sediments etc which may harbour bacteria or provide a nutrient source for them;
- (e) the use of water treatment, for example, treatment chemicals, where it is appropriate and safe to do so; and
- (f) ensuring that the system operates safely and correctly and is well maintained.

27 In drawing up a scheme for controlling risk, account should be taken both of the risk and the costs and practical difficulty of implementing precautions. The various factors that contribute to the risk should be considered and an appropriate package of measures prepared and implemented. Those measures which require little or no expenditure should be implemented immediately; a system of priorities may be used for others placing greatest stress on those water systems which present greatest risk. For health care premises where patients may be at particular risk the Department of Health's Code of Practice *The control of legionellae in health care premises* gives specific guidance (see paragraph 140).

MANAGEMENT AND THE RESPONSIBILITIES AND COMPETENCE OF PERSONNEL

28 Inadequate management, lack of training and poor communication have all been identified as contributory factors in outbreaks of legionnaires' disease. It is therefore important that those people involved in assessing risk and applying precautions are competent, trained and aware of their responsibilities.

29 One person should be appointed as being responsible for overseeing the assessment and implementation of precautions. This person should be a

manager, director or have similar status with sufficient authority to ensure that measures are carried out effectively. Staff responsibilities and lines of communication must be properly defined and clearly set out. Staff must be properly trained and competent. The implementation and effectiveness of the precautions must be monitored, and staff with a role to play in taking precautions must be supervised. Arrangements should be made to allow for staff who leave or are absent from duties so that precautions are still implemented.

30 Communications and management procedures are particularly important where several people are responsible for different aspects of the treatment or precautions. For example, responsibility for applying precautions may change when shift work is involved, or the person who monitors the efficacy of a water treatment regime may not be the person who applies it. In these circumstances, responsibilities should be well defined in writing and understood by all concerned. Communications should be 'fail-safe'. This also applies to outside companies and consultants who may be responsible for certain parts of the precautionary regime. Organisations should satisfy themselves of the competence of contractors in this area of work before gaining their assistance in treating, monitoring, cleaning plant etc.

RECORD KEEPING

31 To ensure that precautions continue to be carried out and that adequate information is available for checking what is done in practice, a record should be kept showing the information specified in the Approved Code of Practice. Precautionary measures and treatments, monitoring results and remedial work should be logged and signed or initialled by the person who has carried out the work. Sufficient information should be recorded to show what measures have been taken and how they have been monitored.

32 The detailed information required in the log will depend on the type and complexity of the system or water service to which it applies and this is dealt with in later paragraphs dealing with particular systems.

RESPONSIBILITIES OF MANUFACTURERS, IMPORTERS, SUPPLIERS AND INSTALLERS

33 Manufacturers, suppliers and installers of plant and chemicals should ensure that their products do not contribute to the risk of legionnaires' disease or, where this is impractical, it should be possible to control the risk.

34 The precise responsibility of manufacturers etc will depend on the type of product, the extent of their role

(whether they only supply the product or if they install and commission it), the risk it presents and local conditions. Each case may need individual consideration. Some examples of these responsibilities are:

- (a) the manufacturers of all plant and appliances should ensure that they comply with water bylaws, that they do not use materials which support the growth of micro-organisms and that plant can be readily drained and cleaned;
- (b) the cooling tower manufacturer should ensure that drift is minimised, drift eliminators are effective, and towers are designed to be cleaned easily;
- (c) system installers should ensure that there are no unnecessary 'dead- legs' and other areas of stagnation, and that the system can readily be cleaned and disinfected;
- (d) the installer or consultant should ensure that the system is properly designed, installed and commissioned and will work safely.

35 Manufacturers and suppliers should provide adequate information for the user on correct operation and means of controlling the risk. Suppliers of products such as water treatment chemicals should provide information on their correct and safe use, including conditions of use, taking into account the operation of the equipment, water conditions and their compatibility with other chemicals in the water.

36 Where a supplier also provides a consultancy service, as is often the case with water treatment companies, care should be taken to ensure that it is adequate and that responsibilities and the lines of communication with the user are clearly set out. In particular, the frequency and timing of service visits, tests to be carried out, the method of reporting and action to be taken if problems are detected, should be formally agreed at the outset. The level of service should be determined by the needs of the system, not by the value of chemicals or other products sold. Consultants' visits should be made when necessary, not just when convenient, and there should be a procedure to ensure that any reports sent by post do not go astray.

HOT AND COLD WATER SERVICES

The risk

37 Figure 1 shows typical hot and cold water services in a large building. Legionella may colonise storage tanks, calorifiers, pipework and associated plant such as

water softeners and filters, and outlets including taps, showers and other appliances. Proliferation can occur whenever conditions, and especially temperatures, are ideal for growth.

38 In practice, legionella is likely to proliferate in various parts of the system, for example:

- (a) *in water storage tanks and in plant such as water softeners.* This is most likely if the tanks and associated plant and pipework become warm (if they are in a warm part of the building such as a plant room or a roof space subjected to solar heat gain), if they are poorly insulated and if use is intermittent. The risk from this source will be small if water is subsequently stored and distributed at the temperatures advocated in paragraph 50;
- (b) *in calorifiers.* These are a major source of proliferation if the calorifier, or parts of it, contain water at 20°C to 45°C. Water in storage calorifiers often stratifies so that although temperatures in the bulk of the calorifier may be high there will be a cooler zone below the heating coils where legionella can multiply. This is rarely a problem if the calorifier is in constant use and the offtake is steady. However, if use is intermittent, or there are sudden increases in demand so that the cooler water is not heated for a sufficient time, or if standby calorifiers are brought into use before the water is adequately heated throughout, legionella laden water may be drawn into the distribution system;
- (c) *in 'dead legs' such as intermittently used water services leading from the main circulating water system to taps or appliances and other pipework connected to the system.* Lukewarm water can stand for long periods in pipes serving intermittently used taps and appliances and legionella may proliferate in them.

39 Legionella is therefore most likely to multiply in calorifiers where water temperatures are insufficiently high and in pipework leading to taps and showers. Some large hot water systems do not incorporate a calorifier but heat water instantaneously before circulating it and proliferation may occur if water temperatures are below 50°C.

40 Cold water services present little risk in normal circumstances although there may be some danger from large cold water systems if use is intermittent, if water temperatures can exceed 20°C, for example, due to high ambient temperatures and inadequate insulation, or if water is taken from sources such as boreholes. While the risk is generally small, it may be significant in premises where occupants are particularly susceptible.

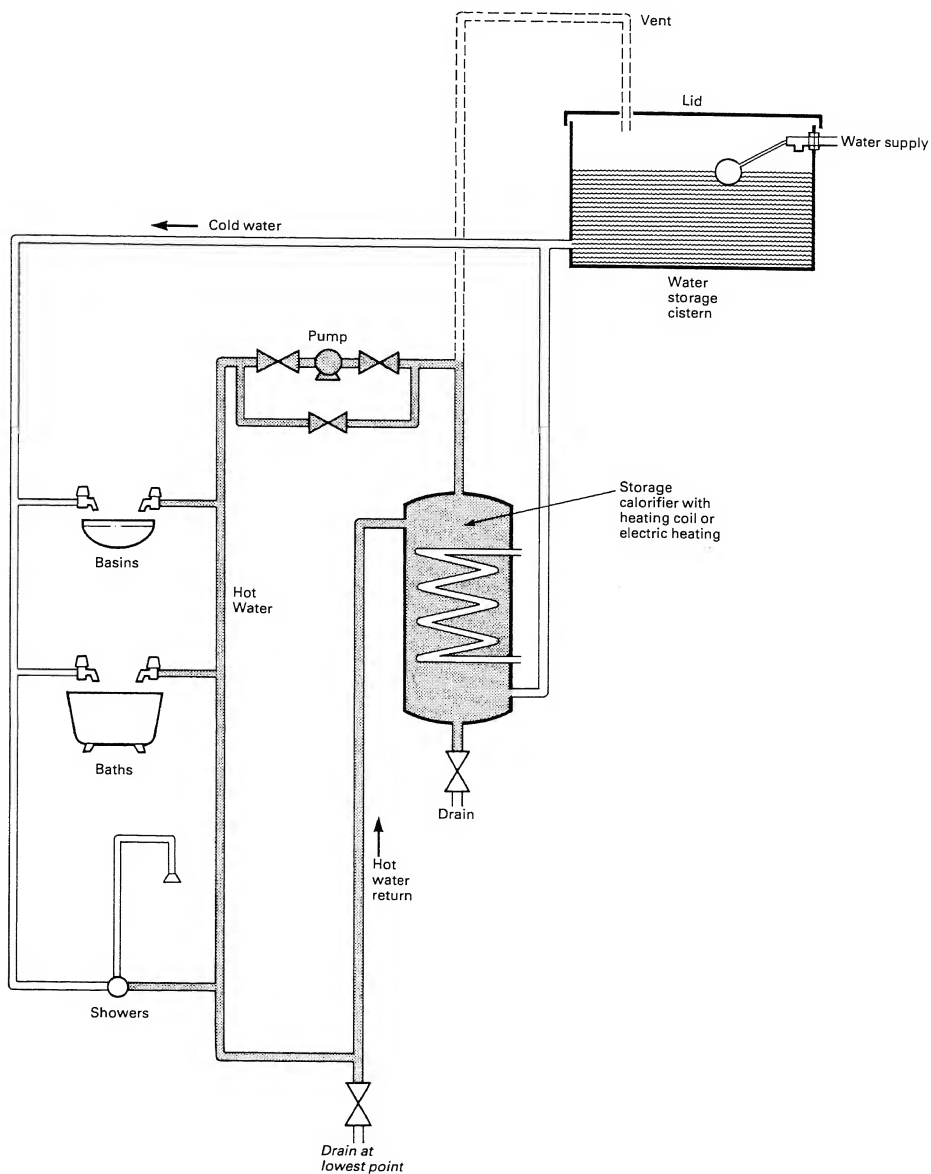


Figure 1 Hot and cold water services

Precautions

41 Having assessed the risk it will be necessary to determine the appropriate precautions. The main objective is to operate water services at temperatures which do not permit the growth of legionella and to avoid stagnation. It is also important to ensure that the system is clean in order to minimise the opportunity for bacterial contamination.

Selection of materials

42 Certain fittings and materials used in the construction of water systems may support bacterial or fungal growth. Examples include leather, some rubbers, jointing compounds and mastics, wooden packing and certain plastics. Once an unsuitable fitting has become colonised it may continue to seed the water system. It is often difficult to identify such fittings without assistance from the water company. *The water fittings and materials directory*, published by the Water Research Centre, lists fittings and materials which are acceptable under bylaws for connection to the mains water supply. Their address is: Henley Road, Medmenham, PO Box 16, Marlow, Bucks SL7 2HD.

System design and construction

43 Water supply tanks and other parts of the distribution system should be well enclosed to prevent foreign matter entering. Tanks should be covered by lids with overlapping edges which are secured to the tank. Overflows should be protected by mesh screens. Tanks should not be oversized and, where two or more tanks serve the same system, it should be designed so as to ensure that water flows through both tanks. Tanks installed in warm roof spaces and plant rooms may need to be insulated.

44 Calorifiers should be capable of heating their contents to the required temperature throughout. If stratification occurs in a calorifier to such an extent that water temperatures throughout the calorifier do not reach 60°C (when there is no draw off) it may be necessary to provide a means for heating water in the bottom of the calorifier, eg by an immersion heater or a pumped circulation from the top to the bottom of the calorifier. These are not intended to operate continuously; they should be timer operated to heat the contents of the calorifier to 60°C throughout for an hour when there is no draw off (usually at night).

45 Tanks, calorifiers and other items of plant should be readily accessible for cleaning. If necessary, it should be possible to isolate them and they should incorporate drain connections at the lowest points which are large enough to permit the removal of sludge and drain the plant quickly. Where possible, pipes should be installed so that they fall towards the lowest point in the system (to avoid pockets of water when the system is drained)

and a drain connection should be provided at this point.

46 Pipework should be as short and direct as possible, especially where it serves intermittently used taps and appliances. The need for intermittently or infrequently used taps and appliances should be reviewed; if they are not necessary the supply pipe should be cut off as far back as possible and removed.

47 If calorifiers and pipework cannot be designed to meet the temperatures required in paragraph 50, or if the system necessarily incorporates 'dead-legs', consideration should be given to other means of preventing legionella from colonising it. Techniques available include:

- (a) on-line pasteurisation of circulating water by raising its temperature to a level at which legionella is rapidly killed, then cooling it in a heat exchanger to a suitable circulation temperature; and
- (b) trace heating of 'dead-legs', either to maintain water at over 50°C in pipework or to raise it to higher temperatures to achieve thermal disinfection on a regular (usually weekly) basis.

48 Suppliers of pasteurisation or trace heating systems should be asked to verify their suitability and efficacy. The performance of some trace heating systems designed to maintain water at 50°C may gradually deteriorate and it is important that this should not occur and result in water being held at lower temperatures in the pipework.

49 Where possible, the layout of cold services and tanks should ensure that water does not become warm. For example, tanks and pipework should not be positioned close to heat sources or where they could be affected by solar gain unless they are effectively insulated.

Operation

50 Water services should operate at temperatures that prevent the proliferation of legionella, that is:

- (a) hot water storage (calorifiers), 60°C;
- (b) hot water distribution, at least 50°C attainable at the taps within one minute of running;
- (c) cold water storage and distribution, 20°C or below.

51 At water temperatures above 50°C there is a danger of scalding which increases with temperature. The risk depends both on temperature and time of contact. At 50°C the risk to most people will be negligible. However, the risk to a few people, particularly young children, the very old, and to those with sensory loss, will be greater.

52 Where the risk of scalding is great, the use of 'fail-safe' thermostatically controlled mixing valves (ie valves which are unaffected by changes in water pressure and automatically close the hot water supply if the cold water falls) will allow the hot water system to run safely at the higher temperatures recommended in paragraph 50.

53 Where the water temperature advocated in paragraph 50 cannot be maintained, regular thermal disinfection of the system may be an alternative. This is described in paragraphs 66 to 68. The frequency of disinfection will depend on the characteristics of the system and the water quality; in most cases it will be appropriate to carry it out on a weekly basis. Alternatively, on-line pasteurisation may be considered where it is impractical to store water at 60°C. A further option is to continuously chlorinate water to 2 mg/litre; although continuous chlorination of building water services is unusual it has been successfully adopted for some hospital water services.

54 If a calorifier or substantial part of the system is on stand-by operation, or if it is out of use for a week or longer for maintenance or other purposes, water should be raised to the operating temperature (60°C) throughout for at least an hour before being brought back into use.

55 Particular attention should be paid to the maintenance and operation of water softeners and filters. These should be maintained and backwashed at the required frequency and to the manufacturer's instructions. Coarser filters and strainers should be checked and cleaned regularly to prevent the build up of organic contaminants.

Routine inspection and maintenance

56 Water services should be routinely checked and inspected, and should be well maintained. The frequency of inspection and maintenance will depend on the system and the risk it presents. For most systems in stable operation it will be sufficient to inspect and check the following:

- (a) water temperatures at calorifiers (monthly);
- (b) water temperatures at taps after one minute running (all taps should be checked at least once a year and a representative number, ideally those nearest to and further from the calorifier, should be checked monthly);
- (c) conditions in tanks, for the presence of organic materials, vermin etc (annually or more frequently if there is reason to suspect contamination);

- (d) conditions in calorifiers, for organic materials and unduly heavy build up of scale (annually);
- (e) the condition of accessible pipework and insulation (annually).

57 Items of plant such as softeners, filters and strainers will need to be checked and inspected on a much more frequent basis, as advised by the manufacturer.

58 The system will require more frequent inspection and checking if it is not in stable operation, eg because of poor supply water quality, inadequate enclosure of tanks or faulty operation of plant. More frequent inspection and checking will also be necessary in buildings where there is a high risk.

59 In some circumstances it may not be possible to inspect items of plant such as calorifiers, because they do not have inspection hatches or because it would entail damaging asbestos insulation. Where this is the case, greater attention should be paid to the operation of the system to minimise the likelihood of malfunction, contamination or scaling.

60 If the inspection reveals contamination, damage or malfunction, remedial action should be taken as soon as possible and the system should be rechecked at frequent intervals until it can be shown to operate safely.

Cleaning and disinfection

61 Water services should be disinfected before being taken into use to remove contamination which may have occurred during construction, in accordance with the British Standard 6700 *Specification for the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages*. They should also be cleaned and disinfected:

- (a) if routine inspection shows it to be necessary;
- (b) if the system or part of it has been substantially altered or entered for maintenance purposes in a manner which may lead to contamination;
- (c) following an outbreak or suspected outbreak of legionellosis.

62 Paragraph 61 applies to those water services where there is a risk of legionnaires' disease, ie hot water services and, exceptionally, cold water services (as discussed in paragraph 40). However, cleaning and disinfection of cold water services is also required by BS 6700 for reasons other than of controlling legionnaires' disease.

63 Water services may be disinfected in two ways:

- (a) by the use of chemical disinfectants, in particular, by chlorination, when it is necessary to disinfect the whole system including storage tanks; or
- (b) by thermal disinfection, ie by raising water temperature to a level at which legionella will not survive.

64 Chemical disinfection is carried out after cleaning by chlorinating the water in the header tank to 20 to 50 mg/litre (ppm), allowing it to flow to all parts of the system (by successively opening the outlets in the system such as taps and showers until there is a smell of chlorine), then closing them and leaving it to stand for an appropriate period. The period depends on chlorine concentration (from at least one hour at 50 ppm to at least two hours at 20 ppm). The required concentration should be maintained in the header tank throughout the chlorination procedure and building occupants should be warned that the water is heavily chlorinated. This treatment should not be carried out by untrained personnel and should be closely supervised. The system should be thoroughly flushed following chlorination. It is important to ensure that all parts of the system are disinfected, not just those which are readily accessible. Chlorine concentration must be monitored throughout disinfection to ensure that there is a sufficient residual chlorine level.

65 If tanks and calorifiers are heavily contaminated by organic materials, the system should be disinfected before and after cleaning and it may be necessary to add chemical dispersants to remove organic fouling from pipework etc. Chemical descaling may also be necessary. Where possible cleaning methods should not create an aerosol (see also paragraph 130).

66 Thermal disinfection can be carried out by raising the temperature of the whole of the contents of the calorifier then circulating this water throughout the system for at least an hour. Each tap and appliance should be run sequentially for at least five minutes at the full temperature, and this should be measured. To be effective, the temperature at the calorifier should be high enough to ensure that the temperatures at the taps and appliances do not fall below 60°C.

67 Alternatively, the circulating pipework and 'dead legs' may be thermally disinfected by means of trace heating. The trace heating system should be capable of raising temperatures of the whole distribution system to 60°C or more for at least an hour.

68 For thermal disinfection the water system needs to be well insulated. The risk of scalding should be considered and particular care taken to ensure that the system is not used, other than by authorised personnel,

until water temperatures have dropped to their normal operating levels.

Records

69 For most hot and cold water services which present a risk of legionnaires' disease, a relatively simple record will suffice. In addition to identifying those responsible, it should include:

- (a) a simple description and plan of the system identifying storage and header tanks, calorifiers and relevant items of plant, especially water softeners, filters, strainers and pumps;
- (b) details of the risk assessment;
- (c) details of system operation relevant to controlling the risk, and the precautions to be implemented;
- (d) procedures for inspecting and checking the system;
- (e) details of precautions carried out including:
 - (i) a record of water temperatures;
 - (ii) a record of operation and checking of plant such as water softeners;
 - (iii) an inspection record including results and subsequent action;
 - (iv) a record of cleaning and disinfection, including details of chlorination levels, temperatures and contact time.

AIR CONDITIONING AND INDUSTRIAL COOLING SYSTEMS

The risk

70 Figure 2 shows a typical air conditioning system. Heat from the refrigeration cycle is removed by the condenser which may be cooled by air or, more commonly, by water from a cooling tower. Such water is typically heated to temperatures in the region of 30°C and, since it can become heavily contaminated by airborne dusts, biological slime, scale and sludge, it provides an ideal environment for the growth of aquatic organisms including legionella.

71 Cooling towers readily generate fine water droplets as they operate by distributing water over a packing material through which there is a counter-current flow of air. Unfortunately in large modern buildings the cooling tower and air inlet to the air conditioning system are often situated close together at roof level, so that the

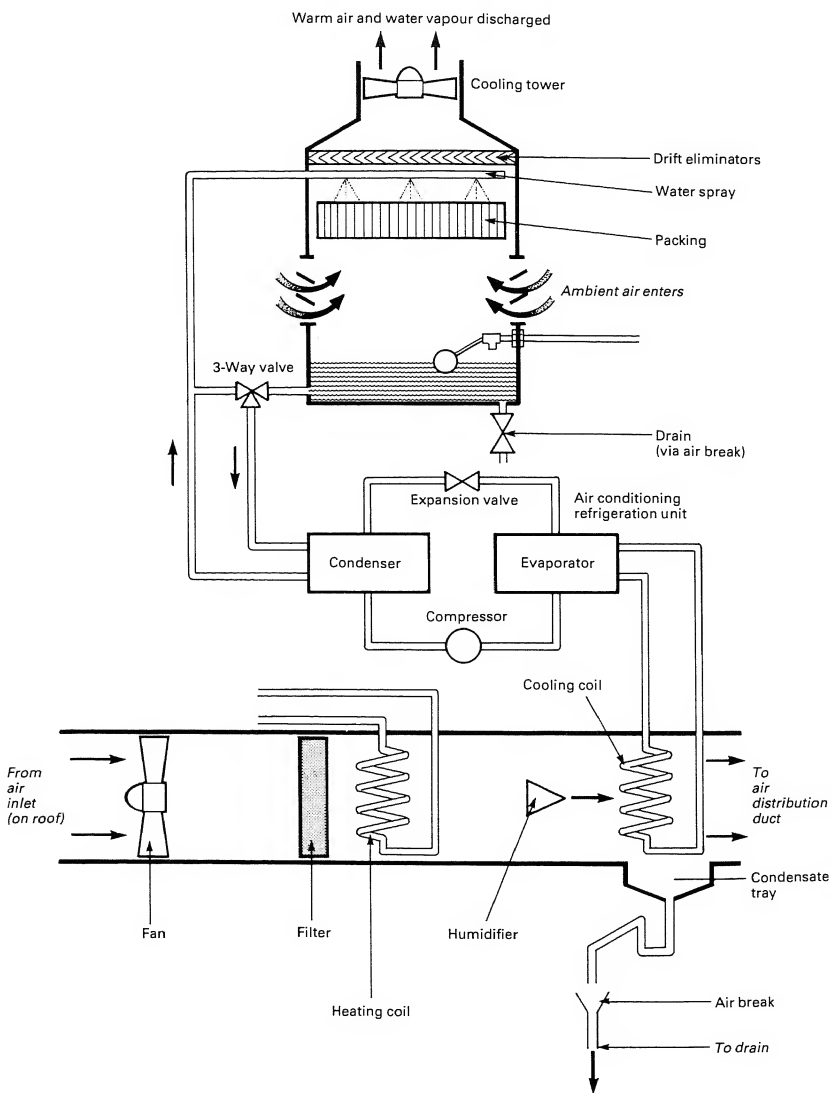


Figure 2 Air conditioning system served by cooling tower

aerosol from the tower may be drawn into the air conditioning system under certain weather conditions. It may also enter the building through open windows and it can be carried some distance from the building by air currents.

72 Cooling towers serving air conditioning systems have caused a number of outbreaks of legionnaires' disease, some resulting in considerable loss of life. The risk exists not only to people in the building where the tower is sited but also to passers-by and to people some distance from the tower. In an outbreak in 1988 people were infected up to 500 metres from the tower concerned. The risk from such towers must therefore be regarded as considerable.

73 Cooling towers are also used for many industrial cooling applications and these have caused some outbreaks. The risk presented by such plant will depend on their operating conditions, as some operate at much lower temperatures than air conditioning towers and may therefore present less risk. Most industrial cooling systems operate at water temperatures which are ideal for legionella and are often polluted by the process and so should be considered to present a significant risk. However, no cases have been attributed to the very large natural draught towers of the type used for electricity generation.

74 Evaporative condensers are sometimes used for air conditioning or industrial cooling applications. The evaporative condenser combines the functions of both the cooling tower and the conventional condenser as water is sprayed directly over the cooling coils. The volume of water in the evaporative condenser is less than in a cooling tower system and the control of water quality may be more difficult. Cases of legionellosis have been attributed to evaporative condensers. They should therefore be regarded as presenting a similar risk, and requiring similar precautions.

75 Water standing in ductwork and condensate trays may represent a potential source of infection. Water can enter the duct from leaking equipment and pipes, from humidifiers or as condensation from duct mounted cooling coils. It may become contaminated, either directly by particles drawn through the air inlet or indirectly from the drain if there is no air break between the condensate discharge and the drain. Condensed water is initially below 20°C but will warm to the ambient temperature if allowed to stand in the duct or tray. Such water will be scoured by the air flow in the duct: while air velocities are generally low and water droplets are unlikely to be picked up in normal circumstances, aerosols may sometimes be created.

Alternative methods of cooling

76 In some circumstances it will be possible to use

alternative methods of cooling. Dry cooling, for example, using air blast coolers or air cooled condensers, will avoid the risks presented by a cooling tower or evaporative condenser. The option of dry cooling should therefore be considered, particularly when cooling towers are due to be replaced or when new cooling systems are planned.

77 Large dry cooling systems, however, have some disadvantages. They are generally larger and heavier than cooling towers so they may be impractical where there are space and load limitations. They may also be noisier and, while running costs and energy use are comparable for small units, cooling towers are generally cheaper to run for larger systems (although this may not always be the case). There may also be problems of compatibility when connecting a dry cooler to an air conditioning system previously served by a cooling tower.

78 These drawbacks will be partially offset by reduced maintenance requirements and savings in the use of water treatment chemicals, cleaning and disinfection costs, regular monitoring and management costs. In practice, each case must be considered on its individual merits.

Precautions

79 The risk of legionnaires' disease from cooling systems can be controlled by:

- (a) careful attention to the design and construction of the cooling tower and cooling system to ensure that the release of aerosol is minimised, the materials used in their construction do not harbour or provide nutrients for bacteria and they can readily be completely drained and cleaned;
- (b) positioning towers away from ventilation inlets and populated areas if possible;
- (c) maintaining the system in a clean and sound condition;
- (d) controlling water quality;
- (e) carefully monitoring precautions.

80 Some of these elements, especially those relating to the position, design and construction of cooling towers, will be difficult to apply to existing installations. These should be considered when towers are replaced or new towers installed. Where an existing installation does not meet the standards recommended, greater care will be needed in applying and monitoring those precautions which are reasonably practicable. However, four elements are essential to the safe operation of *all* cooling systems served by cooling towers or evaporative



condensers - the use of effective drift eliminators, regular cleaning and disinfection, water treatment and monitoring of maintenance and water treatment practices.

81 Note that legionella will proliferate not just in the cooling tower, but throughout the water cooling system, so precautions apply to the whole system.

Cooling tower position

82 Cooling towers should be positioned as far away as possible from air conditioning and ventilation inlets, opening windows and occupied areas, taking note of the prevailing wind direction and the wind distribution over neighbouring buildings (air may be drawn back into the lee of a building by wind eddies).

Design and construction

83 Cooling systems should be designed and constructed so as to minimise the release of drift and to aid safe operation and regular cleaning and disinfection. In particular:

- (a) *all* cooling towers, whether new or existing, should have effective high efficiency drift eliminators. Drift eliminators are normally positioned at the top of the tower where air is discharged in order to intercept water droplets. Wooden slats used for this purpose in the past do not control the smaller droplets and are no longer acceptable. Modern eliminators, usually made of plastic or metal, are more effective and should be fitted to all towers. The manufacturer or supplier of towers or drift eliminators should be able to advise on their suitability and efficiency at intercepting droplets. Note that operating conditions, especially discharge air velocity, may affect the efficiency of drift eliminators;
- (b) the area above the cooling tower pond should be as well enclosed as possible to reduce the effects of 'windage'. Wind movements around the tower may cause drift to escape through the sides, especially if it is poorly enclosed. This is particularly significant when the tower runs with its fan off. It may also be necessary to screen the tower or its pond to prevent the entry of birds, vermin, leaves or other debris or contaminants;
- (c) the water distribution system within the cooling tower should be designed to create as little spray as possible;
- (d) cooling systems and towers should be constructed and installed in a way which will aid cleaning and disinfection. Parts of the tower which become wet should be accessible for cleaning, packing should

be readily removable and easily dismantled - especially in smaller towers - and the pond should have a sloping bottom with a drain connection at the lowest point large enough to carry away water and slurry quickly. A suitably sized drain-down valve should be located at the lowest point so that the entire system can be conveniently and completely drained, including all pipework and items of equipment. It may be necessary to fit supplementary drain valves to the bottoms of individual items of equipment;

- (e) the tower should be constructed of materials which can be readily disinfected and which do not support microbial growth. Where possible, the use of wood should be avoided since this can harbour micro-organisms and may be damaged by chlorinated water.

Air conditioning ductwork and plant

84 Ventilation and air conditioning systems should be designed so that water, whether from the supply or from other sources such as condensation, cannot accumulate in ductwork or plant which is subjected to an air stream. Where water is discharged into a common pipe or drain, the discharge should incorporate an air break or other suitable device to prevent potentially contaminated water from being drawn back into the ventilation or air conditioning system. These points are illustrated in Figure 3.

Commissioning, operation and maintenance

85 Cooling systems should be operated and maintained carefully and correctly. The installer should provide operating instructions giving adequate information on the safe operation of the system.

86 Systems should be properly commissioned before use to ensure that they operate correctly and within the design parameters. This will apply both to new installations and to existing installations which have been substantially altered.

87 A number of outbreaks have been associated with the start up of new cooling systems or following a period out of use. It is essential that precautions are taken to control the risk during commissioning and start up as well as during normal operation of the system. Commissioning and start up procedures should include detailed precautions necessary to control risk.

88 Cooling systems and towers should be kept in regular use where possible. Where a system is used intermittently or it may be needed at short notice, one option is to ensure that it is run once each week. It should at the same time be dosed with water treatment chemicals and water quality should be monitored. The

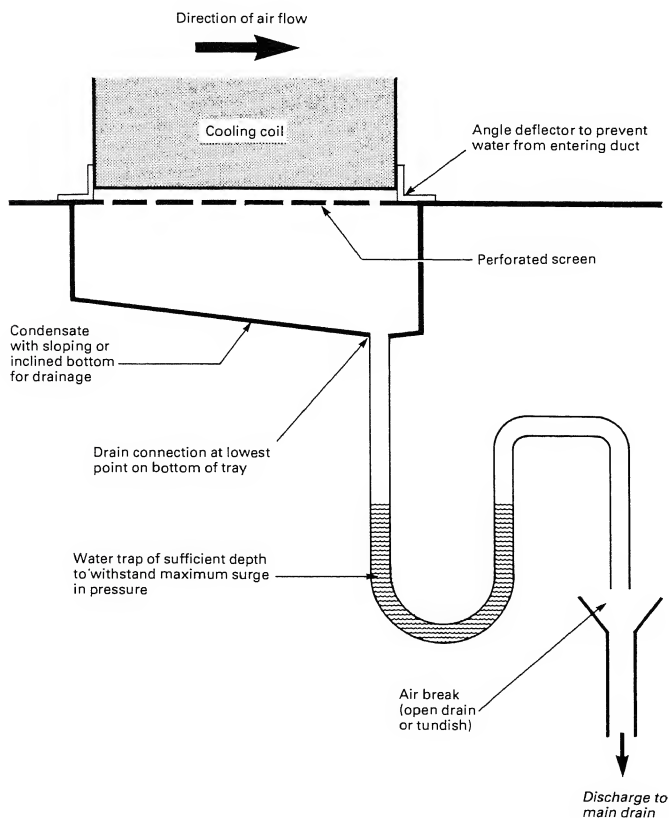


Figure 3 An air conditioning condensate drain

whole system should be run for long enough to thoroughly distribute treated water. If a system is out of use for a week or longer the water should be treated with biocide immediately on reuse and if out of use for a month or longer it should be drained, cleaned and disinfected immediately before reuse. This applies both to normal operation and commissioning periods.

Cleaning and disinfection

89 Cooling systems need to be cleaned and disinfected at appropriate intervals in order to prevent conditions which permit legionella to multiply, and to allow water treatment chemicals to work more effectively.

90 Cleaning and disinfection should be carried out:

- (a) immediately before the system is taken into use to remove contamination which may have occurred during construction;
- (b) if the system, or part of it, has been out of use for a significant period (see paragraph 88);
- (c) if the system or part of it has been extensively altered, entered for maintenance or otherwise disturbed in a manner which may lead to contamination; and
- (d) at regular intervals which depend on the system and premises involved, or as indicated by the results of routine monitoring.

91 For cooling towers serving air conditioning systems, cleaning and disinfection are needed twice yearly (early spring and early autumn). More frequent cleaning may be necessary in particularly dusty atmospheres or where monitoring shows that the water quality is no longer controlled. Those systems which have a short, seasonal use should always be cleaned and disinfected immediately before being taken back into use.

92 Industrial cooling systems should also be cleaned in early spring and early autumn except where this is not possible for operational reasons (see paragraph 93). Industrial cooling systems vary greatly in size and in their operating conditions. In some environments it may be necessary to clean the system more frequently, especially if it becomes contaminated by organic materials such as dust or oil from the process. Cleaning frequency in these circumstances will be determined by inspection and monitoring of water quality.

93 Because of their size or the nature of the process, some industrial cooling systems cannot be cleaned so frequently. Where it is not reasonably practicable to stop the process in order to clean the cooling system, other measures such as on-line cleaning should be considered

and those measures which are reasonably practicable should be applied and monitored with particular rigour.

94 Cleaning and disinfection should normally be carried out in the following order:

- (a) water in the system should be chlorinated to at least 5 mg/l of free residual chlorine and biocides added to disperse materials and biofilms in the system. (Some biocides are not compatible with chlorine). This level of chlorine should be maintained for five hours while the water is pumped throughout the system. The fans should be turned off during water circulation and if possible openings to the tower should be closed off, for example, by plastic sheeting;
- (b) the system should be drained and all accessible parts cleaned. The method adopted for cleaning will depend upon the system. To minimise aerosol creation, surfaces should preferably be scraped and washed down carefully with a disinfectant solution. Metal or wooden components may be steam cleaned but this would not be possible for parts of the tower such as the pack and drift eliminators which are made of plastic. It will often be possible in small and medium sized towers to remove the pack and drift eliminators for more thorough cleaning. Large quantities of sludge may be shovelled or sucked out from the cooling tower pond, and the remnants can then be hosed to a drain;
- (c) the whole system should be sluiced out until the water going to drain is clear. It should then be refilled and the water chlorinated. A level of free residual chlorine of between 5 and 15 mg/l should be maintained for five hours while the water is circulated through the system. The chlorine level should be checked hourly; if it falls below 5 mg/l during this time the chlorination should continue until at least 5 mg/l has been maintained for five hours. Again, fans should be off and if possible openings should be closed.

95 Cooling towers are sometimes cleaned by water jetting. This process can create a considerable spray which may contain organic debris and possibly legionella from deposits in the system so that while it has the advantage of cleaning surfaces thoroughly, the process may itself present a risk. Water jetting should therefore only be used when there is no reasonable alternative and care should be taken to protect both the operators and those in the vicinity. Loose materials and sludge should be removed as far as possible by the method described in paragraph 94 before water jetting starts, operators should wear suitable respiratory protective equipment (see paragraph 132) and windows and ventilation inlets should be closed or the building should

be unoccupied. Water jetting should not be carried out while there are unprotected people and passers-by in the vicinity. (See paragraphs 130 and 131).

96 Hard scale is often difficult to remove by normal cleaning methods and while small quantities of scale will have little adverse affect, large quantities will make effective cleaning difficult and may shelter organic material or micro-organisms. Scale should be removed as far as possible and if, following cleaning, large quantities remain it may be necessary to use chemical descaling methods. Since these employ mild acids, care needs to be taken in their use. If scaling occurs rapidly, this may indicate that the operation of the system and the water treatment regime need review.

97 Where surfaces need to be recoated following cleaning and disinfection, the coating material should be suitable and not encourage or harbour bacterial growth.

Free residual chlorine

98 Chlorine is highly reactive and will combine rapidly with organic material in the cooling system. The level of available chlorine will therefore rapidly decline if the system is heavily contaminated. Chlorine may also attack, and be absorbed by, wooden components in the tower. It is also released as water cascades over the tower. It is therefore essential to add enough chlorine to overcome these losses and to maintain the required concentration.

99 The efficacy of chlorine as a biocide or disinfectant is also affected by the alkalinity of the water. As pH rises its efficacy is reduced. When using chlorine it is therefore necessary to monitor free residual chlorine levels throughout disinfection in order to ensure they are of the required concentration, and the pH of the water to ensure that its efficacy is not impaired. This is discussed in greater detail in the Department of Health's *Report of the Expert Advisory Committee on Biocides* (see paragraph 140).

Water treatment of cooling systems

100 Water treatment is required to prevent corrosion and the build up of materials and organic growth in the system. Traditionally this was to maintain its efficiency. However, the risk of legionnaires' disease from cooling systems means that the control of legionella is now a particularly important consideration.

101 To control legionella, the water treatment regime should include the use of:

- (a) scale and corrosion inhibitors, to reduce the quantity of scale and rust that might otherwise protect legionella in the system;
- (b) dispersants, to disperse sediment and allow other

water treatment chemicals to work more effectively;

- (c) biocides to reduce or prevent the multiplication of bacteria and other organisms in the water, including legionella.

102 The relationship between legionella and other materials and organisms in water is complex and not fully understood. Selection of an appropriate water treatment regime is complicated by the potential effect of different chemicals on each other, on the materials of the system and by the risk to anyone who may be exposed to them. It will therefore be necessary to seek advice from a consultant or a reputable water treatment company.

103 Water treatment will not be effective unless the system is clean. If there are deposits or other contaminants in the water system these may prevent the water treatment chemicals, and especially biocides, from working effectively. In particular, biocides will react with and be used up by organic materials. It is therefore important to ensure that the water system is clean and there is an effective system for monitoring water quality.

104 Biocidal treatment is an essential part of the water treatment regime. This may involve chlorination of water or the addition of other biocides on a regular basis and/or physical methods of treatment in order to kill or control organisms including legionella. Effective biocide treatment will also help to prevent the build up of biofilm (slimes) on surfaces in the system which might shelter legionella and allow it to multiply unhindered.

105 Regular chlorination of 1 to 2 mg/l is normally advocated for the control of legionella although concentrations of 0.5 to 1.0 mg/l may be effective in large cooling systems. Higher concentrations may sometimes be needed if water quality deteriorates but since chlorination above 2 mg/l can increase corrosion in the system, regular dosing at higher concentrations is not advocated. Chlorine is normally added as sodium or calcium hypochlorite in liquid form or as a complex chlorine releasing agent in tablet form. It has the advantage that free residual chlorine levels in the water can readily be measured but it cannot always be used because it is not compatible with some water treatment chemicals such as certain corrosion inhibitors. Chlorine is rapidly lost and its effectiveness is reduced at pH values above 8, ie if the water is alkaline (see paragraph 99). The use of chlorine as a biocide should not be confused with its use as a disinfectant, as discussed in paragraphs 89 to 94.

106 Other biocides may be effective against legionella if added in sufficient concentrations for sufficient time. These include oxidising biocides such as bromine releasing compounds, and non oxidising biocides which

are generally complex organic chemicals. It is common practice to add two biocides on an alternating basis in order to avoid biocide resistance within the microbiological population and because few biocides are broadly active on all organisms.

107 The Department of Health's *Report of the Expert Advisory Committee on Biocides* (paragraph 140) discusses the efficacy of biocides commonly used against legionella. However, biocides are often supplied as proprietary mixtures. If a proprietary biocide is used the supplier should be asked to provide test data to substantiate any claims about the effectiveness of the biocide in field trials, and to confirm the necessary concentrations and contact times.

Setting up the water treatment regime

108 When setting up a water treatment regime it will first be necessary to ensure that the system is clean and to determine its operating conditions and the volume and quality of the water to be treated. The quantities of biocide and other treatment chemicals to be dosed into the system should be calculated initially from the volume of water in the system, and any likely losses during use. The quality of 'make-up' water supplied to the system is also important. If potable water from the mains is used then this will normally be of high quality but if water is taken from boreholes, ponds, rivers or from other non-potable sources it may be significantly contaminated by organic materials and organisms including legionella. Water supplied through holding tanks and softeners may also be contaminated by legionella. The water treatment regime should cater for the added burden from such sources and in some cases the make-up water may need to be treated before use.

109 Wherever possible, biocides should be automatically dosed. While manual dosing can be effective it relies on the operator conscientiously adding chemicals in the required order, time and frequency and to the right part of the system. Failure to do so has contributed to past outbreaks.

110 Where cooling systems are to be chlorinated, this may be done continuously. Otherwise they should be treated at least once per day with chlorine levels being sustained for long enough to control organic growth.

111 Where proprietary biocides are used they are generally added on a 'shot' basis. The biocide will be added in sufficient quantity to maintain the required concentration for the required time, typically a matter of hours, as biocides gradually break down or dissipate. The frequency of dosing will depend on the system; biocides need to be added at least every week and often more frequently.

Alternative methods of water treatment

112 Physical methods of water treatment are under development, including pasteurisation (heating to a temperature at which legionella will not survive) and irradiation by ultraviolet light. Such techniques have the potential advantage that they may replace the use of chemical biocides. However, a disadvantage is that they usually treat water in a pumped treatment loop, not in the main body of the system, and once they have stopped operating there is no residual biocidal effect. In a clean cooling system this may not cause problems but once a biofilm has formed on surfaces it will not be controlled by such treatments. Ultraviolet irradiation can only be effective if the water is clear and so it will usually be necessary to install filters in conjunction with ultraviolet systems.

113 Such physical methods of water treatment should therefore be regarded as part of the treatment regime, not as a complete alternative, since they need to be used in conjunction with inhibitors and dispersants and may need to be supplemented by the use of biocides. The suppliers of such systems should be asked to provide data to verify their efficacy and to advise on what additional measures will be required to ensure adequate control of water quality.

114 Water quality may also be improved by filtration. It is common practice to incorporate strainers in a cooling system to remove larger suspended particles but these will not remove smaller particles. Filters are also available to remove much of the finer suspended matter. These play a valuable role in keeping cooling systems clean and may enhance the water treatment regime.

Dissolved solids

115 Cooling water contains dissolved solids which increase in concentration as water is lost from the system by evaporation. To maintain these at an acceptable level, water is discharged from the system, either at a continuous low rate or periodically at a greater rate, and replaced by fresh water. This may be done automatically by monitoring water conductivity and when this reaches a predetermined level a valve operates to discharge cooling water which is then replaced by clean make-up water. Care is needed to ensure that water is not discharged during or immediately after the dosing of water treatment chemicals since this may result in dilution of biocide concentration in the water to below the optimum effective level.

Monitoring and routine checking

116 If precautions are to remain effective the condition and performance of the cooling system will need to be

monitored and water quality routinely tested to ensure that the water treatment regime continues to control water quality. This should involve:

- (a) checking the performance of the system and its component parts, as recommended by the designer or installer of the system;
- (b) inspecting the cooling tower and accessible parts of the system for damage and signs of contamination;
- (c) testing water quality to ensure that the treatment regime continues to control to the required standard.

117 Cooling systems should routinely be inspected and their performance monitored. The frequency will depend on the system; for well maintained systems in premises where there are no high risk factors, where the system is operating correctly and where water treatment is automatically dosed and the dosing equipment incorporates malfunction alarms, a weekly check together with a monthly test of water quality may suffice. For other systems, this will need to be carried out more frequently.

118 Testing of water quality is an essential part of the treatment regime and should include testing of both the recirculating water and make-up water supplied to the system. Testing may be carried out by a water treatment company or consultant or by the operator, provided they have been trained to do so and are properly supervised. A series of tests should be carried out of the chemical and microbiological condition of the water. The results of testing should be interpreted by a suitable experienced and competent person and any remedial measures be carried out promptly.

119 Where the system is treated by chlorination it is important that free residual chlorine and pH should be measured. Where non-oxidising biocides or physical methods are used for controlling microbiological activity it is not at present feasible to measure biocide levels in cooling water and it will therefore be necessary to measure the microbiological activity itself (techniques for measuring biocide concentrations in water are currently being developed).

120 The most convenient way to measure microbiological activity is to use 'dip slides'. These are plastic slides with a coating of agar - a medium on which micro-organisms will grow. The dip slide is dipped into the cooling water, then placed in a small container and allowed to incubate in a warm place for 24 to 48 hours. The incubation period and temperature should be the same each time the test is performed in relation to a particular water system. Unless this is done it becomes difficult to interpret the results from dip slide tests

performed over a period of time, as different organisms grow within different temperature ranges. Bacteria will grow to form colonies on the agar and by comparing these with a comparison chart the level of contamination of the water can be gauged. Alternative techniques are available for laboratory measurement of microbiological activity and new techniques are being developed for testing on site.

121 The use of dipslides and similar techniques has limitations. They do not specifically indicate the presence or proliferation of legionella but are generally to indicate trends in microbiological quality. If the cooling system is cleaned and disinfected and the water treatment regime is properly set up from the start then dip slides can be used to show whether it continues to be effective or whether remedial action, either by modification of the treatment regime or cleaning and disinfection of the system, needs to be taken. The timing of dip slides and other microbiological sampling is important; results attained must be considered in the light of the state of the system, eg when biocide was last added and the system cleaned.

122 Tests may need to be carried out more frequently when there are changes in the condition or performance of the system, and especially if the regular inspection shows the water to be cloudy or contaminated following cleaning and disinfection. Cleaning of the system releases organic material and unless this material is completely removed and the system effectively disinfected, it may lead to an increased rather than a reduced microbiological activity.

123 If, on inspection, the water is found to be cloudy or visibly contaminated this may indicate poor microbiological control. The visible condition of the water is not necessarily a good indicator of its microbiological condition since contaminants will not necessarily be organic and, conversely, relatively clear water may be unacceptably contaminated. However, it will indicate that further investigation is warranted.

Records

124 For cooling systems the record should, in addition to identifying those responsible, include:

- (a) a description and plan of the system including all items of plant which are cooled by the system and details of the make-up water source. Details should also be included of water treatment plant or equipment and the volume of water in the system should be recorded;
- (b) information on the correct and safe operation of the system and ancillary plant including water temperatures;
- (c) information on precautions to be taken and their

efficacy. Such precautions include the correct application of the water treatment regime, cleaning and disinfection measures and frequency, and monitoring requirements;

- (d) a log showing measures carried out ie water treatment, dosing, cleaning and disinfection, appropriate maintenance and inspection and monitoring results. The log should be signed or initialled by the person carrying out the measures, and should contain sufficient information to show that the work has been done properly. Where part of the work, for example, water quality monitoring, has been carried out by outside consultants their reported results should be kept with the log.

SPAS AND WHIRLPOOL BATHS

125 A spa is a bath or small pool in which bathers sit while warm water is constantly recirculated, often through high velocity jets or with the injection of air to agitate the water. The water is not changed after each user; instead it is filtered and chemically treated. The water temperature typically exceeds 30°C and the deliberate agitation can create a spray or aerosol above the surface of the water. Spas have been linked with various infections including legionnaires' disease.

126 Careful maintenance, frequent cleaning of equipment such as filters, and regular water treatment are essential if the danger of infection is to be avoided. The Swimming Pool and Allied Trades Association, 1a Junction Road, Andover, Hants SP10 3QT (Tel 0264 56210) publish a guide, *Standards for commercial spas: installations, chemicals and water treatment*, which provides advice on this subject.

127 A whirlpool bath is a bath fitted with high velocity water jets and/or air injection, but which does not incorporate water recirculation (ie the water is discharged after each use). They do not, therefore, present the same dangers as spas but the precautions which apply to hot water services are appropriate.

HUMIDIFIERS AND AIR WASHERS

128 Atomising humidifiers and spray-type air washers may incorporate, or take water from, reservoirs or tanks which can store water at temperatures in excess of 20°C. Unless they are regularly cleaned and maintained they can become very heavily contaminated, especially in industrial environments. The water is sprayed in the air conditioning system or, in some industrial applications, directly into the workplace.

129 The risk can be avoided by using humidifiers which do not create a spray, ie steam or evaporative humidifiers. Where humidifiers are used which create a

spray the risk should be controlled by ensuring that the equipment and the water supplied to it is kept clean, ie by regular cleaning and disinfection and not allowing water to stand for more than a day or so in equipment or tanks, especially in warm conditions. Using water direct from the mains water supply rather than recirculated or stored water will also reduce microbiological contamination, but equipment will need approval under water bylaws. Water treatment chemicals are not recommended for use in humidifiers and air washers when buildings are occupied.

PROTECTION OF PERSONNEL

130 Maintenance, cleaning, testing and operating procedures should be designed to minimise the risk to staff and others who may be affected. For example chlorinating cooling towers and evaporative condensers to at least 5 ppm free residual chlorine prior to draining will have only a transient effect on legionella but it will reduce the chance of engineering staff being exposed while working on the tower. Where possible, cleaning methods which create spray, for example, high pressure water jetting, should be avoided. If this is not possible, the operation should be carried out when the building is unoccupied, or in the case of a permanently occupied building, windows in the vicinity should be closed and air inlets temporarily blanked off. As systems requiring cleaning will have a high organic load the operator and others closely involved in the work should wear suitable respiratory protective equipment.

131 Often treatment plant and chemicals are located in confined areas. Guidance on precautions for entry into confined spaces are given in Guidance Note GS5 *Entry into confined spaces*.

132 At present, no respiratory protective equipment (RPE) has been specifically tested for use against aerosols containing legionella but it is recommended that high efficiency, positive pressure respirators with either a full facepiece or a hood and blouse should be used. Further information on RPE can be obtained from *Respiratory protective equipment - legislative requirements and lists of HSE approved standards and type approved equipment* and also, HS(G)53, *RPE - a practical guide for users* (see paragraph 140). Personnel using RPE must be adequately trained to do so and equipment must be properly maintained.

133 Because water treatment chemicals, including chlorine-containing chemicals and solutions, are often toxic or corrosive they should be used cautiously to ensure that they do not endanger the users or other occupants of the building. Proprietary biocides should never be used in drinking water or in hot or cold water services and should not be discharged into sewers, storm water drains or natural watercourses without the prior permission of the relevant water company (in

Scotland, regional and island councils for discharges to sewers and river purification boards for streams and controlled waters). Contact may also need to be made with the National Rivers Authority who may have responsibility for direct discharges into watercourses. Water treatment chemicals are not recommended for use in humidifiers and air washers when buildings are occupied.

134 Water treatment should be carried out by, or under the direction of, people who are suitably qualified and experienced.

ACTION IN THE EVENT OF AN OUTBREAK

135 Legionnaires' disease is not a notifiable disease in England and Wales. Legionnaires' disease, Pontiac fever and Lochgoilhead fever, as legionellosis, are all notifiable in Scotland. Cases of legionellosis may attract the requirements of the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1985 (RIDDOR).

136 Where an outbreak is suspected in England and Wales, the Medical Officer of Environmental Health (MOEH) of the district health authority should be informed. The MOEH has responsibility for the co-ordination of the investigation of outbreaks of notifiable diseases, and is a central figure in liaison with local authorities, health services and the Public Health Laboratory Service (PHLS). To assist in outbreak investigation, the MOEH may request support from epidemiologists from the Communicable Disease Surveillance Centre (CDSC) of the PHLS in London.

137 In Scotland, an outbreak or suspected outbreak should be reported to the Community Medicine Specialist (Communicable Diseases and Environmental Health Group) or the designated medical officer who can call for advice from the Communicable Disease (Scotland) Unit (CDSU) as well as local consultant microbiologists. Legionellosis is a notifiable disease in Scotland under the Public Health (Notification of Infectious Diseases) (Scotland) Regulations 1988.

138 The Health and Safety Executive may be involved in the investigation of outbreaks under the Health and Safety at Work etc Act 1974. Local authority environmental health officers may also be involved.

FURTHER GUIDANCE

139 Advice on water sampling and treatment and on materials suitable for construction, which comply with water bylaws, can be obtained from water companies. Details of water suppliers are given in *Who's who in the water industry 1991* published for the Water Authorities Association by Turrent Wheatland Ltd, Penn House, Penn Place, Rickmansworth, Herts.

140 The following guidance documents on legionnaires' disease and related topics are an additional source of useful information:

Approved Code of Practice for the prevention or control of legionellosis (including legionnaires' disease) Health and Safety Executive HMSO 1991 ISBN 0 11 885659 6

Control of substances hazardous to health: and control of carcinogenic substances Control of Substances Hazardous to Health Regulations 1988 Health and Safety Executive Approved Code of Practice (L5) 2nd edition HMSO 1990 ISBN 0 11 885593 X

The control of legionellae in health care premises: A Code of Practice Department of Health and Social Security HMSO 1989 ISBN 0 11 321208 9

Second Report of the Committee of Inquiry into the outbreak of legionnaires' disease in Stafford in April 1985 Department of Health and Social Security HMSO (CM256) 1987 ISBN 0 10 102562 9

Report of the Expert Advisory Committee on Biocides Department of Health HMSO 1989 ISBN 0 11 321190 2

CIBSE Technical Memorandum (TM13) *Minimising the risk of legionnaires' disease* Chartered Institution of Building Services Engineers 1987 ISBN 0 90 095334 9

British Association for Chemical Specialities *A Code of Practice: The control of legionellae by the safe and effective operation of cooling systems 1989* Sutton 1989 ISBN 0 95 149500 3

British Standard 6700: 1987 *Specification for the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages*. Available from: British Standards Institution, Sales Department, Linford Wood, Milton Keynes MK14 6LE Tel: 0908 221166

Swimming Pool and Allied Trades Association *Standards for commercial spas: installation, chemicals and water treatment* Caterham 1986 ISBN 0 94 882401 8

Respiratory protective equipment - legislative requirements and lists of HSE approved standards and type approved equipment Health and Safety Executive HMSO 1990 ISBN 0 11 885428 3

Respiratory protective equipment: a practical guide for users HS(G)53 Health and Safety Executive HMSO 1990 ISBN 0 11 885522 0

Guidance Note GS5 *Entry into confined spaces* Health and Safety Executive HMSO 1977 ISBN 0 11 883067 8

For details of how to obtain Her Majesty's Stationery Office (HMSO) publications, see back cover.

